Modeling and Measurement

The Modeling and Measurement Department performs applied earth science research and provides critical technical expertise for the Idaho Completion Project, Environmental Affairs, and numerous other site operations. The Department bridges the gap between basic research and applied technology development and implementation. Staff members possess a wide range of expertise and work in areas ranging from bench-scale research to consulting services.

Core sample from the subsurface.

Applied and basic research activities include:

- Developing reservoir engineering techniques for delineating and understanding reservoir behavior
- Performing air pathway contaminant transport assessment and modeling
- Investigating and developing new measurement techniques for air pollution
- Developing risk assessment methodologies to support various Department of Energy (DOE), Environmental Protection Agency, and State of Idaho requirements
- Performing mesoscale experiments coupled with numerical simulations to develop better models of flow in fractured rock vadose zones
- Performing test bed experiments to validate landfill cap and cover performance.

Environmental and operations support includes:

- Site characterization and remediation
- Multipathway contaminant fate and transport modeling
- Human health and the environmental risk assessment
- Performance assessments and composite analyses.

The staff of 40 scientists, engineers, technicians, and post-doctoral researchers hold degrees and experience in geology, geochemistry, hydrology, physics, chemistry, subsurface modeling, atmospheric and surface transport modeling, geophysics, reservoir engineering, health physics, and other earth science and engineering disciplines. Primary customers include DOE's Office of Science, Fossil Energy, Energy Efficiency, and various DOE sites. The Department also performs work for the Environmental Protection Agency and Bureau of Reclamation and supports the Idaho Completion Project. INL foresees additional opportunities with all of these customers.

Site Characterization and Remediation. Staff members with experience in environmental compliance, soil and groundwater sampling, aquifer testing, geochemistry, hydrology, geophysical imaging, remediation, and environmental regulations are at the heart of virtually every environmental cleanup and applied field research effort at INL. Work includes evaluating the nature and extent of contamination at hazardous, radioactive, and mixed-waste sites; evaluating the potential health risk of releases; predicting contaminant fate and transport through computer modeling; evaluating remedial strategies; and conducting performance assessments and composite analyses.

Subsurface and Contaminant Transport Modeling. The department's staff perform applied modeling in support of environmental investigations and basic research. Researchers are conducting advanced modeling studies to better understand and predict the flow and transport of water, vapor, and contaminants in saturated and unsaturated subsurface environments. They are also involved in developing new modeling tools to increase the reliability (reduce uncertainty) of modeling predictions. Staff are skilled in developing conceptual models; identifying appropriate hydrologic,

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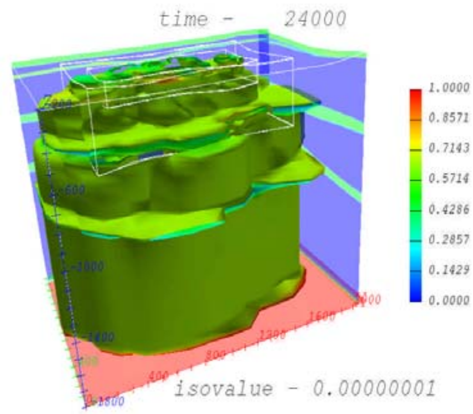

Simulated nitrate

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chemical, and transport parameters for modeling purposes; and performing and interpreting simulation results. Inverse models for parameter estimation and uncertainty analysis are also being developed. Radiological and Toxic Chemical Environmental Assessment. Researchers are studying how radiological and toxic chemical releases impact human health and the environment. The Department's staff support air-permit development; Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) human health and environmental risk assessments; waste site performance assessments; waste characterization and sampling; and varied safety analyses. Staff include environmental health physicists and environmental scientists with experience in environmental transport modeling and dose assessment. Analysts integrate exposure assessments and biokinetic modeling into contaminant transport models.

Energy Sciences

Research staff apply numerical and analytical models to better support DOE's energy mission and energy science needs. Models are being developed to correctly predict the phase behavior in geothermal and fossil energy reservoirs, the formation and behavior of methane hydrates, and carbon sequestration methods. Conventional reservoir simulation is also being coupled to geophysical models in order to better monitor energy resources. These modeling studies are complemented by analytic tools used to predict flow paths and velocities in the subsurface.

Basic and Applied Research

Research staff are developing innovative numerical methods to develop a better understanding of subsurface processes and to provide conceptual models that can be applied to the prediction of the behavior of subsurface contaminants. Smoothed particle hydrodynamics, dissipative particle dynamics, lattice Boltzmann simulations, and level set methods are being employed to model multiphase fluid flow in complex fracture apertures and pore spaces. Geostatistical methods and wavelet analysis are being used to characterize subsurface heterogeneities, and stochastic differential equations are being developed to describe the transport of subsurface contaminants.

The Department operates the INL Fracture Flow Laboratory, which is dedicated to conducting experiments at a scale sufficiently large (mesoscale) to improve understandings of how multiple flow and transport parameters interact at the field scale to influence and/or control subsurface fluid flow. Results from this research will improve predicted simulations of contaminant transport from hazardous and radioactive waste sites. Recently, the laboratory has been performing experiments to address the integrity of landfill covers. Tests have been conducted to (a) evaluate the degradation of geomembranes by repeated freezing and thawing, (b) evaluate the integrity of soil covers after repeated wetting and drying, (c) look at how subsidence influences cover performance.

Staff are also involved in the development and application of advanced methods to measure and assess atmospheric transport of air pollutants. Advanced trace-gas analyzers coupled with meteorological measurements and dynamic surface-to-air flux chambers are being used to assess the transport and cycling of mercury across regional scales and to understand source contributions. The staff have also developed and applied multivariate receptor modeling techniques, which use measured chemical fingerprints to quantify a specific source's contribution to fallout at locations where plumes from many sources mix.

For more information

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